

REMARKS

By this response claims 1, 4, 7, and 19 have been amended, claim 8 has been canceled, and claims 27-31 have been added. Claims 1-7 and 9-31 remain pending. Reconsideration of the application as amended is respectfully requested.

Rejections under 35 USC §112

Claims 19-26 have been rejected under 35 USC §112 as being indefinite, specifically for lacking proper antecedent basis for "the oxide layer." Claim 19 has been amended according to the Examiner's suggestion, which overcomes the rejection under 35 USC §112.

Rejections under 35 USC §102

Claim 1 has been rejected under 35 USC §102(b) as being anticipated by Sashida, et al. (US Pub. 2001/0012659). Referring to FIGS. 5B, 5C and ¶72, Sashida recites forming a first oxide film 6 (ferroelectric oxide), forming a second oxide film 15 (TEOS) using silane, etching a window 16 through the second oxide film 15, then forming an upper electrode from ruthenium (¶58) on the on the first oxide film 6. Because Sashida is forming an oxide layer 15 using silane (SiH_4), Sashida must have some form of oxygen available as a reactant within the chamber along with silane, otherwise no oxide layer could form. This oxygen is therefore a necessary reactant to form oxide layer 15.

The present invention as recited in rejected claim 1 comprises novel differences over the disclosure of Sashida. For example, claim 1 recites "forming an oxide layer" and "exposing the oxide layer to a compound consisting essentially of a silicon-containing gas selected from the group consisting of silane...". The present specification at ¶19 states that the treatment of the oxide with silane is performed "without adding additional thickness" to the dielectric, and thus oxygen is not present as a reactant during the exposure of the oxide to silane. Sashida requires a source of oxygen, otherwise layer 15 would not form, and without the formation of layer 15 Sashida would not expose layer 6 to silane during formation of layer 15. Thus claim 1 as amended is novel over Sashida.

As the present specification discusses the exposure of the oxide layer to silane "without adding additional thickness" to the oxide, and does not discuss the inclusion of oxygen or another reactant during the exposure to silane, support necessary for the amendment is provided. The language "consisting essentially of" refers to additional reactant gasses, and would allow for nonreacting diluents.

Claim 1 has been rejected under 35 USC §102(b) over Fujii (US 6,053,791). Referring to column 11 and FIGS. 19A-19C, Fujii recites the formation of a CVD silicon dioxide layer over glass to form a substrate 1 (lines 35-40), "hydrophobically" treating the substrate using a "silane coupling agent," and forming a conductive film which may be Ru (column 8 line 11).

The Examiner uses the "silane coupling agent" to teach "silane" of present claim 1. However, silane is an inorganic compound having the formula SiH_4 , while a "silane coupling agent" may be any one of a variety of organic compounds, none of which has the formula SiH_4 . Exhibits I and II, attached herewith, are submitted as evidence that a "silane coupling agent" is not silane. Thus claim 1 is allowable under 35 USC §102(b) for at least this reason.

Rejections under 35 USC §103(a)

Claims 4-6 have been rejected under 35 USC §103(a) as being unpatentable over Fujii, et al. in view of Terbrueggen et al. (US 2004/0053290).

Referring to column 11 and FIGS. 19A-19C, Fujii recites the formation of a CVD silicon dioxide layer over glass to form a substrate 1 (lines 35-40), "hydrophobically" treating the substrate using a "silane coupling agent," and forming a conductive film which may be Ru (column 8 line 11).

Terbrueggen recites the combination of a chemical treatment with a plasma treatment to make an oxide insulator surface hydrophobic or hydrophilic while leaving non-oxide surfaces such as gold uncontaminated (¶172). In particular, Terbrueggen states that "silanes can be used to make the oxide insulator surfaces hydrophobic or hydrophilic depending on the type of silane that replace the O-H bonds in the aqueous solution" (¶177).

Because Terbrueggen advocates a choice between silanes, Terbrueggen is not necessarily referring to silane (SiH_4), disilane, or methylated silanes, and is not found where the reference indicates the use of SiH_4 . It is not evident that Terbrueggen discusses or suggests specific silanes, thus the combination of Fujii and Terbrueggen would appear to result in the use of the silane coupling agents discussed in Fujii. However, silane is an inorganic compound having the formula SiH_4 , while a "silane coupling agent" may be any one of myriad organic compounds, none of which has the formula SiH_4 . As discussed relative to the rejections under 35 USC §102, attached Exhibits I and II are submitted as evidence that a "silane coupling agent" is not silane.

Because neither Fujii nor Terbrueggen discusses the exposure of an oxide layer to one of the claimed silicon-containing gasses or the mechanism for treatment of their layers with the materials they do suggest, it cannot be assumed that they perform the claimed method which converts "a surface termination of the oxide layer from a hydroxyl-terminated surface to a hydrogen terminated surface." As Fujii and Terbrueggen in combination does not teach or suggest all of the elements of rejected claims 4-6, the rejected claims are allowable over the combination under 35 USC §103(a).

Claims 2-3 have been rejected under 35 USC §103(a) over Sashida as applied to claim 1, and further in view of ordinary skill in the art. As discussed with reference to the rejections under 35 USC §102, Sashida recites forming a first oxide film 6 (ferroelectric oxide), a second oxide film 15 (TEOS) using silane, etching a window 16 through the second oxide film 15, then forming an upper electrode from ruthenium (¶58) on the on the first oxide film 6 (FIGS. 5B, 5C and ¶72). Because Sashida is forming an oxide layer 15 using silane (SiH_4), Sashida must have some form of oxygen available as a reactant within the chamber along with silane, otherwise no oxide layer could form. This oxygen is therefore a necessary reactant to form oxide layer 15.

The present invention as recited in rejected claim 1 comprises novel differences over the disclosure of Sashida. For example, claim 1 recites "forming an oxide layer" and "exposing the oxide layer to a compound consisting essentially of a silicon-containing gas selected from the group consisting of silane...". The present specification at ¶19 states that the treatment of the oxide with silane is performed "without adding additional thickness" to the dielectric, and thus oxygen is not present as a reactant during the exposure of the oxide to silane. Sashida requires a source of oxygen, otherwise layer 15 would not form, and without the formation of layer 15 Sashida would not expose layer 6 to silane during formation of layer 15. Thus claim 1 as amended is novel over Sashida, and rejected claims 2 and 3 which depend therefrom are also allowable.

Claims 7-26 have been rejected under 35 USC §103(a) over Kuroiwa (US 6,187,622) in view of Sashida. Kuroiwa recites forming a conductive layer within a hole 110a and over an insulation layer 110, then etching back the conductive layer using RIE to form a conductive plug 111. The conductive layer may be formed from a metal such as tungsten, titanium, tantalum, etc., or may be formed from polysilicon doped with phosphorous (column 8, lines 34-42).

Forming the plug from polysilicon comprises flowing silane gas (SiH_4) to fill the opening 110a with polysilicon. After forming the plug, a lower electrode 114 is formed in electrical contact with the plug 111, for example from ruthenium (column 8 lines 34-column 9 line 1).

If the plug is formed from polysilicon, a diffusion-prevention layer 133 made from titanium is formed so that the lower electrode does not contact the plug to prevent diffusion of silicon into the lower electrode. Thus with Kuroiwa, the ruthenium will not contact the insulation layer 110 unless the plug is formed from something other than polysilicon, in which case the insulation layer will not be exposed to silane.

Rejected claim 7 recites "flowing a compound consisting essentially of a silicon-containing gas selected from the group consisting of silane...to expose the oxide layer to the silicon-containing gas and...flowing a ruthenium metal precursor into the deposition chamber to form a ruthenium metal layer on the oxide layer." If Kuroiwa flows silane (to form a polysilicon plug), the ruthenium will not be formed

on the oxide layer 110. If the plug is formed from tungsten, the ruthenium may be formed on the oxide layer 110, but the oxide layer will not be exposed to silane. A similar recitation is recited in claims 19 and 26. Thus independent claims 7, 19, and 26, and claims 9-18 and 20-25 which depend therefrom, are allowable over Kuroiwa and Sashida for at least this reason.

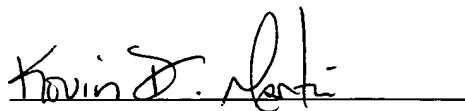
Claim 14 is further allowable over Kuroiwa and Sashida in combination, as it recites that "subsequent to the exposure of the oxide layer to the silicon-containing gas the oxide layer is not thicker than prior to the exposure to the silicon-containing gas, and the exposure to the silicon-containing gas does not form a separate layer of material on the oxide layer." Kuroiwa forms a polysilicon layer resulting from the exposure, and Sashida forms an oxide layer.

Claim 21 is further allowable over Kuroiwa and Sashida in combination. Claim 21 recites "...maintaining the semiconductor wafer substrate assembly at a temperature of between about 150°C and about 350°C during the flow of the silicon-containing gas into the deposition chamber...". Kuroiwa flows silane into the chamber to form a polysilicon layer, but at the claimed temperature, polysilicon is not likely to form. Exhibit III below indicates a temperature of between 580°C to 650°C for polysilicon deposition using the decomposition of silane, and states that at "reduced pressure levels for VLSI manufacturing, polysilicon deposition rate below 575 deg C is too slow to be practical."

Conclusion

If there are matters which may be addressed through a telephone conversation, the Examiner is cordially invited to contact the undersigned. This is believed to be a complete response to the Examiner's office action.

Respectfully submitted,



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